

# ROCKETS AND SHELLS

By ALFRED STETTBACHER

*A well-known Swiss expert on explosives, Dr. Alfred Stettbacher, supplies some up-to-date information on rocket guns and gives his authoritative opinion on recent developments in the field of explosives.—K.M.*

**T**HERE are many thousands of substances which possess explosive properties, but hitherto there have been only very few which could be employed for military purposes. The reason for this is that, while the explosive should be sensitive enough fully to unfold its destructive power within a fraction of a second after the action of the fuse at the target, it must at the same time be stable enough to withstand the tremendous shock it receives when the cannon is fired off, in order not to endanger the men using it. Since the rocket projectile, which is propelled by a charge burning off in its rear part, accelerates gradually without suffering the shock a shell does when it is fired off, far more sensitive and thus more effective explosives can be used in it. Moreover, the uniform, gentle acceleration of the rocket imposes no particular stress on the outer case of the projectile in the way of pressure and rotation. Consequently, much thinner shells can be employed with a correspondingly larger capacity of explosives.

The Germans have been using rocket guns since the beginning of 1943. Six barrels made of sheet iron are mounted on one pair of wheels. These cannons do not require heavy gun carriages and barrels; yet one cannon with six barrels can be as effective as a battery of six normal cannons. Moreover, a three-ton tractor is enough to transport the rocket gun. German rocket gun regiments are divided into batteries and

detachments. Thus it is easy to figure out the number of projectiles which, for example, 12 batteries of four guns (of six barrels each) are able to shoot at a given target. There are three kinds of shells in use at present: explosive, incendiary, and smoke shells. The explosive shells have an effect similar to that of air bombs, as have the incendiary shells. The smoke shells permit the rapid laying of a smoke screen in front of one's own or the enemy's troops.

Rockets have a lower speed and penetrating power than shells, so that they must rely for their effect on their explosive power, mainly the air pressure created thereby, and this to a greater degree than any other projectile propelled by the discharging of a cannon. The range of the rockets probably does not exceed several kilometers, as it is very difficult to aim them properly at greater distances.

## ROCKETS AGAINST BOMBERS

There is no contradiction between these facts and the employment of rockets by the German air force to fight off bomber squadrons. This is an innovation which skillfully makes use of a very old principle for modern purposes, as has been shown by the destruction of numerous Allied bombers in recent months. Let us quote from the report of Colonel Budd J. Peaslee, a co-pilot of an American bomber that participated in the raid on Schweinfurth in October 1943 which turned into a disaster for the Americans:

... we had constantly to fight off German pursuits. At first single-motored pursuits of the Focke-Wulf 190 and Messerschmitt 109 types went for us; a little later these were reinforced by whole chains of two-motored fighters which were apparently equipped with rockets. My rear gunner called through the telephone: "We're getting it now! Sixty of them are in a line behind us!" From then on I saw more rockets than I cared for, and I imagined that it was quite possible that none of us would get back. Each of those



German Rocket Gun



German rocket guns in action. The eye can follow the projectile as it travels with increasing speed through the sky, its fiery tail leaving behind a trail of white smoke. A few seconds later the rumble of the explosion is heard and waves of terrific air pressure flow back

fighters seemed to carry four rockets, which he released at a distance of almost exactly two kilometers. It looked as if they released their rockets as soon as they reached an imaginary chalk line, so accurately did they maintain their distance. During the first two hundred meters of their flight the rockets puffed out clouds of smoke which stayed behind them as long tails; during this part of their flight their speed seemed to increase. Then they exploded with flashes of light twice as strong as those occurring at the explosion of A.A. shells.

My bomber was hit by the splinters of a rocket which exploded near by. After the rocket planes a line of two-motored fighters appeared which were equipped with cannons.

Thus these rockets were shot from a distance of about two kilometers, which is beyond the effective range of a 12.8-millimeter machine gun. By accelerating during the first 200 meters, the speed of the rockets sufficiently exceeds that of the planes (150 meters per second at a speed of 540 km/h) for the rockets to cover the remaining 1,800 meters in perhaps six or seven seconds, after which they should explode and tear the nearest bomber to shreds. The explosive charge may be assumed to be as high as 10 kilograms, i.e., far higher and more effective than that of even the heaviest A.A. shells.

As the rockets are released from a thin barrel in the direction of the bomber squadron, and since it rarely happens that a direct hit is achieved on a plane, the rockets must have a splinter effect calculated for considerable distances. Of course, each

rocket's accuracy in hitting depends greatly on the burning time and this in turn on extremely careful workmanship as well as on the varying influences such as air pressure and temperature at the different levels.

As the equipment for shooting off rockets can easily be improvised and shifted everywhere, this mobile weapon seems especially suited for the defense of an invasion. For as soon as the coastal zone chosen for the landing is under the uninterrupted fire of the approaching two-dimensional armada and all railway lines and roads have been made impassable, it may quite possibly be the rocket, brought out from the safety of deep dugouts, whose screaming splinters will cause havoc all over the landing places and far out into the sea covered

by barges.

#### NEW EXPLOSIVES

It has been known for some time that the heavy Allied bombs weighing several tons contain as their charge two separate liquids, nitrate tetroxide ( $N_2O_4$ ) and a combustible carbohydrate, for instance, toluol or gasoline which, when mixed after the bomb has been released and is falling or even at the target, become a devastating explosive (Panklastit). Lately there has been mention of explosive air or Oxyliquit bombs which contain a firm, absorbent combustible—such as soot or naphthalene powder—which, shortly before the bomb is released, is soaked with liquid oxygen (the comburant) from special tanks, making it into the most powerful of explosives. At any rate, patents were taken out in the early days of this war for aerial bombs with liquid contents, with either a separating wall or a breakable container for one liquid within the other.

The Panklastit as well as the Oxyliquit class are—pound for pound—among the most powerful of all explosives, and it would seem obvious to use these liquids in artillery shells too, to obtain charges for special purposes. Most suitable for artillery, as its boiling point is as high as 126° centigrade, is tetranitromethane in conjunction with a soluble carbohydrate such as toluol, benzol, or nitrobenzol.

Illustrations 2, 3, and 4 show the proportion of the weight of the explosive charge to the total weight of the shell in the case of the two new liquid charges and the old TNT shell.

Keeping two liquids separate in a shell from the moment of discharge till the shell has left the barrel (to prevent an explosion in the barrel) is technically an easy matter, a similar method being employed as for the safety stop for the detonator in an ordinary shell. The pressure of acceleration and the rotation of the shell set off a gadget which releases the safety stop. The space to contain the explosive charge can be enlarged considerably, as long as the wall of the outer case remains thick enough safely to withstand the strain of pressure and rotation. It is quite possible that projectiles are already being produced with twice or three times as big a charge, and this in turn twice as powerful and with twice the speed of detonation as TNT shells of the same caliber.

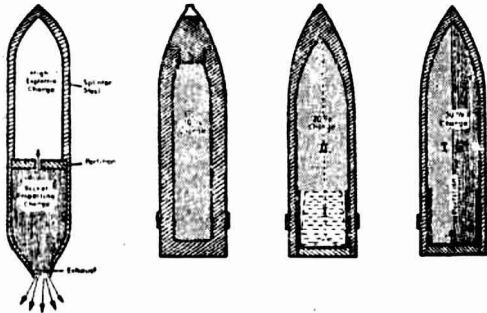


Fig. 1 Fig. 2 Fig. 3 Fig. 4

Fig. 1. Diagram of an airplane rocket (without stabilizers). When the propelling charge has burned down to the insulating partition, the fire penetrates to the high-explosive charge and detonates it.

Fig. 2. Ordinary A.A. or field artillery shell charged with a solid, stable explosive (10% of total weight). Explosive power: 950-1,000 kcal/kg and 6,000-7,000 m/sec detonation speed.

Fig. 3. Diagram of a new armor-piercing shell charged with two separate liquids (20-30% of total weight), which are mixed at the moment of impact and detonate after the shell has pierced the object. 1,700-1,800 kcal/kg and 8,000-9,000 m/sec detonation speed.

Fig. 4. Diagram of a new high-explosive shell with a charge of at least 30% of the total weight. The separated liquids are mixed as a result of the rotation of the shell as soon as the latter leaves the barrel, to detonate with a terrific explosive power at the first impact. Energy also as much as 1,800 kcal/kg and speed of detonation up to 9,000 m/sec.

#### CAN URANIUM BOMBS END THE WAR?

Now let us turn to another "secret weapon" that the world press has been speaking about: the uranium bomb.

In natural as well as in artificial atom disintegration, energies are released which are millions of times greater than those released in the combustion and explosive processes employed by us at present. Thus the element radium disintegrates in 1,590 years to half its original weight and produces 3.7 million kcal per gram, which corresponds to 2.3 million times that weight of dynamite (2.3 tons). Another radioactive element, uranium, which has the atomic weight of 238, disintegrates into helium and lead, but much more slowly, for it takes five billion years for half its original weight to disintegrate. During this natural disintegration, about one thousandth part of the uranium is destroyed, dematerialized and transformed into the vast energy of more than 20 million kcal (corresponding to 12.5 tons of dynamite) for every gram of uranium.

Owing to the infinitely slow speed of the natural disintegration, neither of these two radioactive elements has any explosive power. Nor has it been possible to influence the speed of the natural disintegration by the employment of electricity of even the highest possible tension. On the other hand, it is well known that numerous elements can be split up with the aid of high-tension electricity, but that the yield is infinitesimally small and the energy released correspondingly ineffective. The element best suited for such artificial disintegration was found to be uranium, the heaviest and most unstable of all atoms. However, it was also discovered that only the rare uranium isotope with the atomic weight 235, of which natural uranium with the atomic weight 238 contains no more than 0.72 per cent and which it is hard to isolate, could be disintegrated by means of electricity.

Just before the war, the discovery was made in Berlin that as a result of the artificially provoked atom disintegration, too, approximately one thousandth part of the uranium mass is destroyed with a corresponding equivalent of energy being released. The most recent calculations have shown that, if it were possible to make 1 gram of uranium U-235 vanish in the time of detonation, an explosive power equivalent to that of 10.6 tons of dynamite would be set off. In other words, instead of four

8,000-lb "block-buster" bombs, an airplane would have to release only 1 gram of catalyzed uranium to cause the same destruction on the ground target.

However, the oft-prophesied end of the war through uranium bombs is still a matter of the distant future. It is true that the uranium atom breaks up when bombarded with neutrons and releases one or two neutrons of its own which fly off at a terrific speed. If these neutrons were "caught" in the same way by neighboring uranium atoms, they would cause the same disintegration there with the corresponding release of new neutrons, so that finally an irresistible, avalanche-like chain reaction would explode the entire uranium mass with catastrophic force. However, this obvious chain reaction does *not* set in, because—as

experiments have shown again and again—the border-line conditions for this avalanche process cannot be achieved yet in practice. The concentrations of energy available to us are apparently still much too small in comparison to the unimaginably vast forces holding an atom together. The powers of cohesion within 1 gram of hydrogen have been calculated at 1,400 billion tons, which is equivalent to the weight of a limestone cube 8.14 kilometers high or the weight of a dozen mountains put together. The fact that, for such splitting up with spontaneously spreading disintegration, amounts of energy—detonating charges—are necessary which gigantically surpass our means allows us to infer an order of the world which guards man, if not from his present terrestrial doings, at least from planetary folly.

## TRANSPORT PLANE OR FREIGHTER ?

*The heavy shipping losses suffered by the Allies through the action of German U-boats have entailed the employment of transport planes to an extent undreamed of ten years ago. This has led to a lively discussion on the pros and cons of the movement of freight by planes. Not long ago, the English magazine "Aeronautics," edited by Oliver Stewart, dealt with this subject, and the conclusions it reached are summarized below.—K.M.*

**W**ILL postwar freight movements take place in the air? In order to give a reply to this question, it is necessary to take the various factors into consideration which determine maritime and air transport, for instance the frequent discrepancy in the lengths of the shortest sea and air routes; in the case of air routes, the unequal intervals between landings; the raw-material geography of the various routes, etc. All these factors play an essential role in calculating the necessary units of transport, fuel requirements, and personnel.

What influence do these individual factors exert? On a comparatively short route, such as from San Francisco to Alaska, a plane can cover the distance several times in the time required by a ship for the same journey, so that on this route, for instance, 35 transport planes of the most usual type can transport an equal amount of goods within a given time as a medium-sized freighter. On the route San Francisco/Australia, however, as many as 121 planes are needed for every ship. On this latter route it is the great distance between landings (from one Pacific island airport to the next) which necessitates the carrying

of large quantities of fuel, and naturally this has to be done at the cost of the pay load.

When one considers all these factors, one arrives at the conclusion that air transport cannot compare in economy with maritime transport, as is clearly revealed by our chart. In order to transport 100,000 tons of freight a month from the United States to the Atlantic coast of Europe, 34 freighters with crews amounting to 2,380 men are required if the goods are to go by sea. For air transport, however, taking all factors into consideration, 1,900 transport planes with crews amounting to 22,500 men are required! Thus the requirements in personnel alone would be almost ten times greater in the case of planes.

Now let us turn to the question of fuel. To transport 100 kilograms of freight from America to Europe, a ship uses 7.93 kilograms of fuel; a plane, however, uses nearly 40 times as much, viz., 295.5 kilograms. Consequently, the fuel consumption of the plane is almost three times as great as the pay load it can transport. This applies to the route USA/Europe. The comparison turns out even worse on the route San Fran-